



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1**

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Memorandum

Date: August 5, 2020

Subject: Olin Chemical Superfund Site
Updates to OU1/OU2 RI Report Conclusions

To: File

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PURPOSE AND BACKGROUND

The purpose of this Memorandum is to update the conclusions and findings presented in the August 2015 Operable Unit 1/Operable Unit 2 (OU1/OU2) Remedial Investigation (RI) Report for the Olin Chemical Superfund Site (Site), prepared by AMEC on behalf of Olin Corporation (the 2015 OU1/OU2 RI Report).^{1,2} These updates are based on the application of risk management decisions and a review of data collected from within the Containment Area feature³ at the Site after completion of the 2015 OU1/OU2 RI Report. The updated conclusions and findings presented in this Memorandum support the establishment of the Remedial Action Objectives (RAOs) for the Site and the development of remedial alternatives under consideration in the Feasibility Study (FS) report for OU1/OU2 and the Interim Action FS report (together, FS report).

Section I of this Memorandum provides an overview of the Exposure Areas (EAs) developed during the 2015 OU1/OU2 RI. Section II presents certain updates to the terminology EPA uses to refer to the surface water features at the Site. Section III

¹ *Final Remedial Investigation Report, Operable Unit 1 & Operable Unit 2, Olin Chemical Superfund Site, Wilmington, Massachusetts*, AMEC, July 24, 2015 (2015 OU1/OU2 RI Report).

² EPA has also prepared a companion document to this Memorandum, updating the conclusions and findings presented in the *Revised Remedial Investigation Report OU3, Olin Chemical Superfund Site, Wilmington, Massachusetts*, Wood Environment & Infrastructure Solutions, June 2019. This companion document is entitled, *Memorandum, Olin Chemical Superfund Site, Updates to OU3 RI Report Conclusions*, EPA, August 5, 2020.

³ *Memorandum, Supplemental Characterization of Containment Area Soil, November 2019, Olin Chemical Superfund Site, 51 Eames Street, Wilmington, MA*, Wood, March 20, 2020.

provides a summary of the major conclusions of the 2015 OU1/OU2 RI Report, together with EPA's current position clarifications and/or modified understanding. Section IV provides a summary of major conclusions EPA considers as missing from the 2015 OU1/OU2 RI Report, including a detailed discussion about the Containment Area in Section IV(1). Section V summarizes the RAOs that resulted from the 2015 OU1/OU2 RI results, modified by the analysis presented in Sections III and IV, from which remedial alternatives are screened, developed, and evaluated in the FS report. Section VI provides a list of acronyms. Finally, Attachment A summarizes information on historic waste disposal practices in the Containment Area and Attachment B provides a series of figures.

I. 2015 OU1/OU2 RI REPORT EXPOSURE AREAS

A Baseline Human Health Risk Assessment (BHHRA) and a Baseline Ecological Risk Assessment (BERA; together, risk assessments) were included in the 2015 OU1/OU2 RI Report. OU1 includes all media except groundwater within the portion of the Site that is the 50-acre former manufacturing property located at 51 Eames Street in Wilmington, Massachusetts (Property). OU2 includes off-Property surface water and sediments that have been impacted by Site-related contaminants (Site contaminants).⁴ For the purposes of the risk assessments, exposure areas (EAs) were established to facilitate evaluation of potential risks, centered around known releases and receptors. The BHHRA and BERA EAs are shown on **Figure 1**, *Division of Operable Unit (OU) 1 into Human Health Exposure Areas (HH-EAs) for the purposes of the risk assessments*, and **Figure 2**, *Division of Operable Unit (OU) 1 into Ecological Exposure Areas (E-EAs) for the purposes of the risk assessments*, below. These EAs are referred to as HH-EAx (human health) and E-EAx (ecological), respectively (the "x" in the nomenclature refers to the EA number).

OU2 includes off-Property surface water and sediment. Several off-Property water bodies were investigated during the RI (see **Figure 3**, *Operable Unit (OU) 2 surface water bodies*, below). OU2 surface water bodies to the west of the Property include the following:

- Off-Property West Ditch
- Maple Meadow Brook wetlands area (which includes Sawmill Brook, and Maple Meadow Brook and associated wetlands)

OU2 also includes the following water bodies to the south and east of the Property:

- Landfill Brook
- East Ditch
- North Pond

Because these water bodies are distinct and physically separated, each was evaluated as a separate EA in the risk assessments. No Site-related impacts and no human health or

⁴ OU2 also includes all media except groundwater within Exposure Area (EA) 5 and a portion of EA3.

ecological risks were identified for sediments and surface water in Landfill Brook, North Pond, and the Maple Meadow Brook wetlands area, so no remedial alternatives are included in the FS report for these areas.

II. DESCRIPTION OF OPERABLE UNITS AND UPDATES TO TERMINOLOGY IN THE FS REPORT

The 2015 OU1/OU2 RI Report refers to the following OUs:

- OU1 – Olin Property (former 50-acre manufacturing property, including all media except groundwater)
- OU2 – Off-Property soil, sediment, and surface water areas
- OU3 – Groundwater, including Light Non-Aqueous Phase Liquid (LNAPL) and Dense Aqueous-Phase Liquid (DAPL)

Prior OU1 and OU2 documents, including the 2015 OU1/OU2 RI Report, reference the following “ditches”:

- East Ditch
- South Ditch (and Upper South Ditch and Lower South Ditch)
- West Ditch (and On-Property West Ditch and Off-Property West Ditch)

The above-referenced water bodies were natural features that pre-dated the development of the manufacturing facility. This Memorandum clarifies that current and future documents, including the Proposed Plan and Record of Decision (ROD), shall refer to these features as follows:

- East Ditch Stream
- South Ditch Stream (and Upper South Ditch Stream and Lower South Ditch Stream)
- West Ditch Stream (and On-Property West Ditch Stream and Off-Property West Ditch Stream)

The addition of the term, “stream,” is intended to recognize the natural pre-development status of these water bodies.

III. 2015 OU1/OU2 RI REPORT CONCLUSIONS & EPA UPDATES

Section 8.2 of the 2015 OU1/OU2 RI Report provides a summary of the major conclusions based on the data and assumptions available at that time (see enumerated conclusions below). Generally, the 2015 OU1/OU2 RI Report concluded that “[t]he nature and extent of contamination for on-Property soil, surface water, and sediment of OU1 and the off-Property surface water and sediment of OU2 has [sic] been well characterized and defined,” and that, “[t]he data are adequate to support risk characterization and risk management decisions.” EPA agrees that the nature and extent

of contamination in soil, surface water, and sediments has been well characterized and supports risk characterization. However, this Memorandum documents certain updates to the assumptions and understandings that underlie the 2015 OU1/OU2 RI Report. For example, subsurface soil from within the Containment Area was not investigated during the field program for the OU1/OU2 RI. Updates and conclusions regarding the Containment Area are summarized in Section IV, below.

Presented below in paragraphs (1) through (7) are the major conclusions of the 2015 OU1/OU2 RI Report (*in italics*), followed by EPA's current position clarifications and/or modified understanding:

- 1) *The BHHRA indicates that overall the Property is suitable for industrial/commercial use.*

There are a number of potential future risks posed by the Site that need to be addressed through implementation of a cleanup plan to make the Property suitable for industrial or commercial use. These potential risks are discussed further in the Memorandum, below.

- 2) *One small area of surface soil has reported concentrations of polychlorinated biphenyls (PCBs), which do not pose unacceptable risks to current or future workers.*

EPA agrees with this conclusion. The specific PCB – Aroclor 1260 – was from a transformer leak and was confirmed to be in a small area within the top four feet of soil within HH-EA1 (see **Figure 1**, *Division of Operable Unit (OU) 1 into Human Health Exposure Areas (HH-EAs) for the purposes of the risk assessments*, below). Two samples in HH-EA1 exceeded the Industrial Regional Screening Level (RSL) for PCBs in soil (0.74 milligrams per kilogram [mg/kg]), however, using conservative exposure assumptions⁵, the concentrations of PCBs do not result in an unacceptable risk to trespassers or construction workers at the Site.

- 3) *The [Trimethyl]pentenes or] TMPs in soil in the northeast corner of the Property associated with HH-EA7 and HH-EA3, and to a lesser extent in the former Lake Poly area, could pose potential inhalation risks for indoor workers who may be exposed via vapor intrusion. Therefore, this portion of the Site should be evaluated in a Feasibility Study for potential engineering controls and requirements to mitigate potential future exposure from inhalation of soil dust or vapor intrusion concerns. There is no current vapor intrusion issue because there are no currently occupied buildings on the Site.*

The BHHRA concluded that an unacceptable future inhalation risk to indoor workers in buildings constructed in HH-EA7, HH-EA3, and a portion of the former Lake Poly area could exist due to exposure to TMPs via the subsurface soil-to-indoor air vapor intrusion pathway. EPA agrees with this conclusion, but extends these potential

⁵ See 2015 OU1/OU2 RI Report, Appendix M, *OU1/OU2 Baseline Human Health Risk Assessment*, Attachment 14, *PCBs in Soil – Guard Shack Area*.

inhalation risks to building occupants, as well as indoor workers. These potential inhalation risks need to be managed to ensure the Property remains suitable for industrial or commercial use.

Soil sampling was conducted throughout the main operations area of the Site (HH-EA1), however, due to obstructions related to remaining buildings and concrete foundations, the possibility exists that elevated levels of TMPs may be present in these areas. The limited characterization of soil beneath the remaining facility buildings and foundations introduces the possibility that contaminants such as TMPs could be present at sufficient concentrations elsewhere on the Site to result in unacceptable exposures should buildings be constructed and occupied in areas where elevated levels of TMPs are present that could result in an unacceptable vapor intrusion risk. Mitigation of these exposure pathways should be evaluated in the FS report to make the Property suitable for industrial or commercial use.⁶ Thus, it is appropriate for the RAO for known TMP impacts to apply to the soil located throughout HH-EA1, in the event that additional investigation(s) indicate that elevated TMPs are present in that area.

These documented exposure risks – to future indoor workers and building occupants in HH-EA1, HH-EA3, and HH-EA7 from TMP vapors – contribute to the basis for the RAOs summarized in Section V of this memorandum.

- 4) *The Baseline Ecological Risk Assessment (BERA) indicates that there are no ecological risk concerns in the portions of the Property available for redevelopment. The BERA for OU1 and OU2 also found that adverse site-related effects may be possible for Lower South Ditch⁷ sediment and E-EA5 soil, due to chromium and [bis-2-ethylhexylphthalate or] BEHP. This is consistent with the findings of the sediment toxicity test.*

EPA acknowledges that the sediment toxicity test – known as the 42-day *Hyaella azteca* Sediment Toxicity Test (*Hyaella azteca*) – showed toxicity in Lower South Ditch Stream sediments, documenting mortality of benthic invertebrate population in these sediments. While the test did not attribute the cause to any specific chemical(s), ammonia – a primary Site contaminant in sediments – was intentionally stripped from the *Hyaella azteca* samples prior to toxicity testing because the observed concentrations were known to cause mortality. This suggests that a Site contaminant other than ammonia – likely chromium – contributed to the observed toxic effects.

However, the statement “the BERA indicates that there are no ecological risk concerns in the portions of the Property available for redevelopment” is misleading

⁶ See Technical Memorandum, *Documentation of Preliminary Remediation Goals (PRGs) to Address Human Health Risks in Dense Aqueous-Phase Liquid (DAPL), Groundwater Hot Spots, Upland Soil (including Containment Area soil), and Surface Water at the Olin Chemical Superfund Site*, Wood, July 1, 2020, Section 3.3. To address potential future human health risks [from exposure to] industrial/commercial indoor air, PRGs for TMPs were calculated[.]

⁷ As discussed in Section II, the term “stream” was not used in the OU1/OU2 RI as a descriptor for Lower South Ditch or any of the other ditches, but will be adopted moving forward.

and contains an inaccuracy. Firstly, the FS report considers all risks across the Site, regardless of whether an area is available for redevelopment or not.

Secondly, documented adverse effects to plants and mammals from exposure to chromium and BEHP in soil and sediments are not confined to Lower South Ditch Stream and the E-EA5 soil areas. This is because these same plant and animal habitats are present beyond these limited EAs in other areas of OU1/OU2 that contain actionable concentrations of chromium and BEHP in soil and sediments. In addition to developing remedial alternatives to address contaminated soil and sediments in Lower South Ditch Stream and E-EA5, the development of alternatives in the FS report for soil and sediment should be expanded to include other areas of OU1/OU2 with similar ecological risk concerns and which have actionable concentrations of chromium and BEHP. These portions of OU1/OU2 include E-EA1, E-EA2, E-EA3, E-EA4, E-EA7, the Containment Area, Off-Property West Ditch Stream, and South Ditch Stream.

These exposure risks contribute to the basis for the RAOs summarized in Section V of this memorandum.

- 5) *Therefore, these areas⁸ should be evaluated in a Feasibility Study to address chromium and BEHP.*

EPA agrees, but as explained in the previous response, additional areas to be evaluated in the FS report should include E-EA1, E-EA2, E-EA3, E-EA4, E-EA7, the Containment Area, Off-Property West Ditch Stream, and South Ditch Stream.⁹

These exposure risks contribute to the basis for the RAOs summarized in Section V of this memorandum.

- 6) *Surface water in Upper and Lower South Ditch Streams shows potential adverse effects to ecological receptors, primarily due to ammonia and chromium. Therefore, these specific OU1 and OU2 surface water bodies should be evaluated in the OU1/OU2 Feasibility Study.*

EPA agrees with this conclusion, but extends these potential adverse ecological effects to East Ditch Stream. EPA has concerns that Site contaminants in groundwater in the area of Plant B could potentially impact the ecological quality of East Ditch Stream should Plant B cease operation. Thus, remedial alternatives associated with potential groundwater discharge from the Plant B area to East Ditch Stream should be evaluated in the FS report.

⁸ “These areas” refer to Lower South Ditch Stream sediments and EA-5.

⁹ See Technical Memorandum, *Documentation of Preliminary Remediation Goals (PRGs) for Soils, Sediments, and Surface Water at the Olin Chemical Superfund Site*, Wood, May 15, 2020, Section 1.0. This technical memorandum has been prepared to document the basis for certain preliminary remediation goals (PRGs) for soils, sediment, and surface water in support of the on-going preparation of the Feasibility Study (FS) for Operable Unit 1 (OU1) and Operable Unit 2 (OU2) and of the Interim Action Feasibility Study (IAFS) for the Olin Chemical Superfund Site (OCS).

In addition, management of potential human health risks (dermal contact) to trespassers in Off-Property West Ditch Stream (due to polycyclic aromatic hydrocarbons [PAHs], including benzo(a)pyrene; see Section IV(3), below) should also be evaluated in the FS report.¹⁰ PAHs, specifically, benzo(a)pyrene, have been observed at levels exceeding applicable standards within Off-Property West Ditch Stream. While these compounds may be associated with non-Site-related sources, such as from parking lot or roadway run-off and/or railroad ties, this has yet to be confirmed. Thus, it is appropriate for the RAO for surface water bodies to apply to Off-Property West Ditch Stream, in addition to Upper and Lower South Ditch Stream and East Ditch Stream.

These exposure risks contribute to the basis for the RAOs summarized in Section V of this memorandum.

- 7) *The BHHRA and BERA indicated no human health or ecological risk concerns for OU2 surface water and sediment in the Maple Meadow Brook Wetland and North Pond, and those water bodies do not need to be evaluated in the OU1/OU2 Feasibility Study.*

EPA agrees with this conclusion.

IV. ADDITIONAL CONCLUSIONS NOT INCLUDED IN THE 2015 OU1/OU2 RI REPORT

1) Containment Area – Hazardous/Solid Wastes

Significant volumes of acidic wastewaters and other wastes, including containerized and laboratory wastes from various facility production operations, were disposed of within the Containment Area from approximately 1965 until at least 1983 (see Attachment A). The disposal areas within the bounds of the Containment Area were unlined until 1972. The wastewaters and other wastes percolated through the Containment Area soil and contributed to the formation of DAPL. Specific areas within the Containment Area – primarily the drum and buried debris areas – have been remediated, but these areas represent a fraction of the total extent of the Containment Area. Therefore, unsaturated soil within the Containment Area likely contains waste materials.

¹⁰ See Technical Memorandum, *Documentation of Preliminary Remediation Goals (PRGs) to Address Human Health Risks in Dense Aqueous-Phase Liquid (DAPL), Groundwater Hot Spots, Upland Soil (including Containment Area soil), and Surface Water at the Olin Chemical Superfund Site*, Wood, July 1, 2020, Section 4.0. The 2015 BHHRA concluded that the cancer risk for the trespasser exposed to [Site contaminants] in sediment and surface water in the off-Property West Ditch [Stream] is above the CERCLA acceptable risk range. The main risk contributor for the receptor is the combined ingestion and dermal exposure to surface water for benzo(a)pyrene (B(a)P)...Therefore, a cancer risk-based PRG is calculated based on the B(a)P surface water exposure point concentration, calculated cancer risk, and the target cancer risk of 1×10^{-4} ...

Section 8.2 of the 2015 OU1/OU2 RI Report contained no conclusions with regard to the Containment Area EA, which was evaluated as a separate EA for OU1. The Containment Area structure, including the slurry wall and temporary cap, was constructed in 2000/2001 as a Release Abatement Measure (RAM) under the Massachusetts Contingency Plan (MCP). The structure is comprised of a perimeter slurry wall installed to the top of weathered bedrock, as well as a temporary cap to minimize infiltration of precipitation. The objective of this action was to minimize, to the extent possible, the migration of Site contaminants in groundwater to South Ditch Stream.

During the OU1/OU2 RI, characterization of Containment Area soil was limited to surface samples from beneath the temporary cap, which were collected by cutting slits in the cap and using a hand-held spatula. Deeper samples were not collected at that time to avoid potential damage to the temporary cap that may have resulted from the presence of the drill rig. The results from the surficial samples indicated that low concentrations of some Site contaminants were present in Containment Area soil. The BHHRA relied on these results and concluded that soil in the Containment Area did not pose an unacceptable risk to human health. However, EPA does not agree that the results from these surficial samples are representative of the soil within the Containment Area.

In November 2019, Olin conducted supplemental soil sampling in the Containment Area, following a request by EPA to further characterize Containment Area soil via the collection of additional samples at a variety of depths and determine if the Containment Area materials meet the definition of soil that contains Resource Conservation and Recovery Act (RCRA) characteristic hazardous waste.³³ above

Twelve soil/rock borings were completed in locations that targeted previously excavated areas, former disposal pits and lagoons, and areas with elevated chromium concentrations that may represent locations of former disposal features. Each boring was drilled through overburden soil and advanced 5 feet into the top of bedrock. The 12 locations were selected to coincide with areas that were suspected to be associated with the main historical disposal locations. Analytical results from soil samples collected from these borings showed elevated concentrations of TMPs, BEHP, and total chromium.

Soil sampling results from the 12 borings did not exceed the criteria for RCRA hazardous waste characteristics. Consequently, this data set from the 12 borings does not indicate the presence of RCRA hazardous waste within the Containment Area. However, the sampling data is limited and there exists the possibility that soil containing RCRA hazardous waste is present within the Containment Area feature. Additional sampling would be necessary to demonstrate the absence of non-hazardous wastes within the Containment Area, given the extensive historic disposal that occurred in this area of the Site, as described in Attachment A.

Accordingly, the solid wastes in the Containment Area will need to be contained, a remedial action that would include the prevention of leaching of chemicals or constituents from such wastes, in accordance with RCRA Subtitle D regulations and Massachusetts solid waste management regulations. The Containment Area remedial alternatives evaluation presented in the FS report would require the disposal areas to be remediated or capped and closed in accordance with these requirements. Excavated contaminated soil determined to contain hazardous waste would be managed in accordance with RCRA hazardous waste regulations.

These potential waste characteristics contribute to the basis for the RAOs summarized in Section V of this memorandum.

2) LNAPL near Plant B

Section 8.2 of the 2015 OU1/OU2 RI Report contained no conclusions with regard to LNAPL located on the Property (currently extracted and treated by Plant B) because EPA originally intended that the risks associated with the migration of LNAPL in groundwater was to be addressed under the purview of OU3. However, subsequent to the preparation of the 2015 OU1/OU2 RI Report, it was concluded that LNAPL would be addressed as part of OU1/OU2 efforts and/or interim actions for OU3.

The LNAPL is a processing oil containing BEHP, n-nitrosodiphenylamine (NDPA), and TMPs. Its presence at the Site is the result of a spill in the northeast corner of the Property. This release is separate and distinct from the releases that occurred through the unlined lagoons or pits (located to the south and west of the former manufacturing area, see **Figure 4**, *Olin property features (current and historic)*, below. The LNAPL spill resulted in a release of LNAPL to East Ditch Stream, which abuts the Property to the east. To address this discharge, Plant B was converted into a groundwater recovery and treatment system, tied to three extraction wells which began operation in 1981. Plant B continues to operate today and has reduced the thickness of LNAPL to less than 0.02 feet. The three extraction wells prevent groundwater containing Site contaminants from discharging into East Ditch Stream. The extraction system has also resulted in a large smear zone of LNAPL in soil in this area of the Site.

Exposure to LNAPL was not evaluated in the BHHRA because the 2015 OU1/OU2 RI Report concluded that LNAPL is collected and treated by Plant B and thus does not pose human health risks that require evaluation. However, the 2015 OU1/OU2 RI Report did not evaluate the risks posed by LNAPL in the event that the extraction wells and Plant B groundwater treatment system were no longer operational. Under this scenario, it is assumed that LNAPL would mobilize and once again leach into East Ditch Stream. In addition, groundwater containing Site contaminants, such as BEHP and TMPs, would also be assumed to discharge to East Ditch Stream, as well as South Ditch Stream. The potential exposure risks associated with the release of LNAPL and groundwater containing Site contaminants into the streams contributes to the basis for the RAOs summarized in Section V of this memorandum.

3) Off-Property West Ditch Stream – Risks to Trespassers

The BHHRA component of the 2015 OU1/OU2 RI Report concluded that unacceptable risks to a trespasser could exist from exposure to benzo(a)pyrene and other PAHs in surface water within Off-Property West Ditch Stream but asserted that such contaminants are unrelated to historical activities or releases at the Property and that such risks do not warrant further investigation nor evaluation in the FS report.¹¹

EPA acknowledges the possibility of additional off-site, upgradient commercial/industrial sources of benzo(a)pyrene and other PAHs to the Property.^{12,13} However, benzo(a)pyrene and other PAHs were detected in surface and subsurface soil on the Olin Property, with the highest concentrations occurring in the vicinity of the former Plant C Boiler and the former Laboratory Building Boiler near the Guard Shack.¹⁴ EPA's goal is to reduce, to the extent practicable, any sources of PAHs, including benzo(a)pyrene. EPA has concluded that in the absence of additional data that conclusively rules out the contributions of potential source areas on the Olin Property to surface water in Off-Property West Ditch Stream, surface water impacts in Off-Property West Ditch Stream could be Site-related and that mitigation of these exposure pathways should be evaluated in the FS report.¹⁰

4) Olin Property – Risks to Future Residents

The BHHRA component of the 2015 OU1/OU2 RI did not quantify the future exposure risk to potential residents of the Property. Therefore, this potential exposure pathway was evaluated by EPA to determine whether the FS report needed to address these exposure scenarios should site use change. EPA's evaluation concluded that residential users would have an unacceptable risk from exposure to soil at the Site if the site use changed.¹⁵ This conclusion supports the need to include Institutional Controls in the set of remedial alternatives for the Site, to prohibit future residential use of the Property, which would effectively ensure its foreseeable use remains industrial or commercial.

These documented exposure risks contribute to the basis for the RAOs summarized in Section V of this memorandum.

¹¹ See 2015 OU1/OU2 RI Report, Executive Summary (p. ES-24).

¹² See 2015 OU1/OU2 RI Report, Appendix M, *Baseline Human Health Risk Assessment*, Section 5.2.9, *Off-Property West Ditch*, Section 5.2.9.1, *Current and Future Trespasser* at p. 5-8. The detection of these [polycyclic aromatic hydrocarbons or] PAHs [in Off-Property West Ditch Stream] are potentially related to stormwater runoff from the parking lot located to the west of the [Off-Property West Ditch Stream].

¹³ See Memorandum, *Olin Chemical: Benzo(a)pyrene distribution and surface water impacts*, Nobis, July 20, 2020. Page 2. Additional sampling (such as including BaP in the sample suite for quarterly sampling) may help determine if BaP concentrations are consistent or if [Olin Property] potential source areas are contributing to BaP in the Off-Property West Ditch Stream.

¹⁴ See 2015 OU1/OU2 RI Report, Section 4.1.3.3.1.

¹⁵ Memorandum, *Residential Human Health Risk Evaluation – Olin OU1/OU2 Soils*, Bluestone Environmental Group, January 17, 2020. The unacceptable resident risk is due to contaminants in soil, including benzo(a)pyrene and other PAHs at the Property.

V. REMEDIAL ACTION OBJECTIVES FOR THE FS REPORT

As documented in Sections III and IV of this memorandum, the potential for unacceptable human health and ecological exposures exist within OU1 and OU2 which warrant the development of remedial alternatives. The following RAOs have been established to address the Site contaminants and unacceptable exposure pathways, as documented in the 2015 OU1/OU2 RI Report, the BHHRA and BERA, and this memorandum. These RAOs form the basis for the remedial alternatives screened, developed, and evaluated in the FS report.

1) RAOs for the final Soil and Sediment actions:

- Upland Soil
 - Prevent potential human exposure by a future indoor worker or building occupant to indoor air vapors, via a vapor intrusion pathway, containing Site contaminants at levels that pose an unacceptable risk.
 - Prevent exposure by current and future ecological receptors to upland soil containing Site contaminants that would result in potential adverse impacts.
 - Prevent leaching of Site contaminants associated with the Containment Area into groundwater, surface water, and sediments at levels that pose unacceptable risks to human health and the environment.
- Wetland Soil and Sediments
 - Prevent exposure by current and future ecological receptors to wetland soil and sediments containing Site contaminants that would result in potential adverse impacts.
 - Prevent the further migration of wetland soil and sediments containing Site contaminants to nearby wetlands, surface water, drainage features, and adjoining properties that would result in potential adverse impacts.

2) RAOs for the final LNAPL and Surface Water actions:

- LNAPL
 - Prevent migration of LNAPL to East Ditch Stream to prevent exposure by current and future ecological receptors to Site contaminants that would result in potential adverse impacts.
 - Remove, to the extent practicable, LNAPL that represents a source of Site contaminants to groundwater and a source of TMPs to indoor air vapors, via a vapor intrusion pathway, that pose an unacceptable risk to future indoor workers or building occupants.
- Surface Water
 - Prevent migration of groundwater containing Site contaminants to East Ditch Stream, South Ditch Stream, and Off-Property West Ditch Stream to prevent exposure by current and future ecological receptors

- to surface water containing Site contaminants that would result in potential adverse impacts.
- Prevent migration of groundwater containing Site contaminants to Off-Property West Ditch Stream to prevent potential human exposure by a current or future trespasser to surface water containing Site contaminants at levels that pose an unacceptable risk.

VI. LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
BEHP	bis-2-ethylhexylphthalate
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHHRA	Baseline Human Health Risk Assessment
cy	cubic yards
DAPL	Dense Aqueous-Phase Liquid
EA	Exposure Area
EPA	United States Environmental Protection Agency
E-EAx	ecological Exposure Area number “x”
FS	Feasibility Study
gpd	gallons per day
HH-EAx	human health Exposure Area number “x”
LNAPL	Light Non-Aqueous Phase Liquid
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCP	Massachusetts Contingency Plan
MDC	Metropolitan District
mg/kg	milligrams per kilogram
mil	millimeter
NDPA	n-nitrosodiphenylamine
OU	Operable Unit
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PRGs	Preliminary Remediation Goals
PRP	Potentially Responsible Party
PVC	polyvinyl chloride
RAM	Release Abatement Measure
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
Site	Olin Chemical Superfund Site
TCLP	Toxicity Characteristics Leaching Procedure (TCLP)
TMPs	trimethylpentenes
UCL	Upper Concentration Limit

Attachment A – Summary of Historic Waste Disposal in the Containment Area¹

During facility operations at the Property, waste disposal occurred in the Containment Area from approximately 1965 until 1983. The disposal occurred in the following ways:

1. Unlined Acid Pits. From sometime prior to 1965 until July 1971, untreated acidic wastewaters containing a variety of waste materials (including sodium chloride, sodium nitrate, formaldehyde, processing oil, ammonium chloride, sodium sulfate, sulfuric acid, urea, ammonium sulfate, sodium bromide, chrome oxide, aluminum hydroxide, sodium hydroxide, chlorosulfonic acid, sulfuric acid, ammonium chloride, hydrochloric acid, sodium chlorosulfonate, hexamethylenetetramine, azodicarbonamide, and diisobutylene)² were discharged into the three unlined acid pits located in the northern portion of the Containment Area, as shown on **Figure 4, Olin property features (current and historic)**, below. From July 1971 to February 1972, treated acidic wastewater effluent was discharged into the acid pits. Most of these wastes percolated through the porous soil underlying the pits into the groundwater below, contributing to the formation of DAPL.
2. Leaks from Lined Lagoons I and II and Emergency Lagoon. In approximately 1972, two lined lagoons (Lagoons I and II) and an acid treatment and neutralization system were added to the facility to replace the unlined acid pits and Lake Poly for the disposal of acidic wastewaters. Acidic waste streams were neutralized with lime and discharged to the lined lagoons, which were located almost entirely within the footprint of the Containment Area (see **Figure 4, Olin property features (current and historic)**, below), with the supernatant pumped through a clarifier before discharge. The acid treatment and neutralization system initially discharged to the on-Property ditches. In approximately 1972, the acid treatment and neutralization system was connected to the municipal (Metropolitan District [MDC]) sewer.

According to monitoring data from the late 1970s, the lined lagoons were leaking at that time. Evaluation of sludge and inspection of the Lagoon I liner in the fall of 1981 confirmed that the liner was perforated and allowed leakage of fluids from the lagoon. A 1982 hydrogeologic investigation determined that between 52,900 and 240,000 gallons of wastewater (also described in the report as 8,000 to 10,000 gallons per day [gpd]) leaked through Lagoon I in approximately one month, depending on the porosity value used for the sludge. See Hydrogeologic Investigation for Olin Chemicals Group, Malcolm Pirnie, Inc., February 1982, at p. IV-8. Similar volumes of wastewater were speculated to be leaking from Lagoon II because it was receiving the same sludges and operating in the same fashion as Lagoon I.

¹ The information contained in this summary is from the 2015 OU1/OU2 RI Report, including Appendix A (Historic Study Area Investigations Summary Report) of the RI Report, unless otherwise noted.

² See *Pollution Control Study for National Polychemicals, Inc., at Wilmington, Massachusetts*, The Badger Company, Inc., August 21, 1969, at pp. II-2 – II-4.

In late 1981 and 1983, Olin re-lined the lagoons (the original liners were polyvinyl chloride [PVC]; Olin replaced them with 36 mil [millimeter] thickness hypalon liners). A 1979 study determined that sludge had also been dumped in an emergency unlined lagoon located adjacent to the lined lagoons (and within the Containment Area) when the lined lagoons were filled to capacity. See Site Inspection Report of Olin Chemicals Group Plant, Ecology and Environment, Inc., December 5, 1980, at p. 1-13 (referencing 1979 study by Geotechnical Engineers., Inc.). Accordingly, significant disposal of wastes in the Containment Area through leaks in the lined lagoons and disposal in the emergency lagoon likely occurred until at least 1983.³ After Olin discontinued operations at the facility in 1986, Lagoons I and II were drained and the water was treated to remove sulphate and then discharged to the MDC sewer. The sludge and liners were excavated and disposed of in the Calcium Sulfate Landfill located in the southern portion of the Property. This landfill has received closure under MassDEP.⁴

3. Disposal in Drum Area A, Drum Area B, and in the Buried Debris Area. At some time during historic facility operations, drums and miscellaneous facility wastes were disposed of in Drum Area A, Drum Area B, and the Buried Debris Area (see **Figure 4**, *Olin property features (current and historic)*, below). These areas were initially discovered by Olin during maintenance activities conducted in 1980, identified further by magnetometer survey in the early 1990s, and remediated in 2000. Nearly all of the drums were deteriorated and in poor condition. Drum Area A, Drum Area B, and a portion of the Buried Debris Area were located within the footprint of the Containment Area. Drum Area A consisted of drums and miscellaneous wastes containing NDPA, BEHP, TMPs, and chromium. Drum Area B consisted of drums, laboratory bottles, and miscellaneous wastes containing NDPA, BEHP, phthalates, and chlorobenzenes. The drum areas also contained Opex and Kempore wastes. The Buried Debris Area contained materials similar to those disposed of in Lake Poly.
4. Excavated soil from the Containment Area used to backfill the excavation areas. In late 2000, Drum Area A was excavated to an average depth of 8 feet bgs, and approximately 3,200 cubic yards (cy) of soil, 160 overpacks of old drums, crushed drums and drum parts, and 34 tons of metal debris were excavated from the area. Drum Area B was excavated to an average depth of 6 feet bgs, and approximately 1,150 cy of soil, three overpacks of drum parts, and two tons of metal debris were excavated from the area.

³ Leaks in facility process sewer lines were also repaired in approximately 1983 and 1984, but the precise location of these leaks is uncertain, and they were not likely within the Containment Area.

⁴ See Memorandum, *Olin Chemical Superfund Site, Updates to OU3 RI Report Conclusions*, EPA, August 5, 2020. On January 7, 2009, MassDEP issued to Olin a final closure certification of the CSL and approval of a post-construction monitoring plan.

The debris materials from both areas were removed for off-site disposal as non-hazardous solid waste, and soils were segregated according to visual inspection of the degree of potential impact. The soils were then sampled, tested, and evaluated for disposal off-site or re-use as excavation backfill. Except for approximately 200 cy of soil excavated from Drum Area A (which was sent off-site for disposal), the soil excavated from Drum Areas A and B was determined to be suitable for reuse (all contaminant concentrations below MassDEP Upper Concentration Limits [UCLs]). Approximately 500 cy of soil excavated from Drum Area B had to be stabilized with cement and calcium sulfate due to high organic content (peat) before being used as backfill. The Drum Area A excavation was backfilled with a mixture of excavated soil determined to be suitable for reuse, blast rock, and on-Property borrow. Drum Area B was backfilled with a mixture of excavated soil determined to be suitable for reuse and on-Property borrow.

During September and October 2000, approximately 2,315 cy of impacted peat and sediment were excavated and removed for off-site disposal from the Buried Debris Area. Approximately 250 cy of granular material excavated from the Buried Debris Area was used as backfill in the Containment Area in November 2000. Additionally, approximately 50 cy of sediment excavated from the delta area in October 2000 was tested for re-use and was used as shallow fill in the Containment Area.

Attachment B – Figures

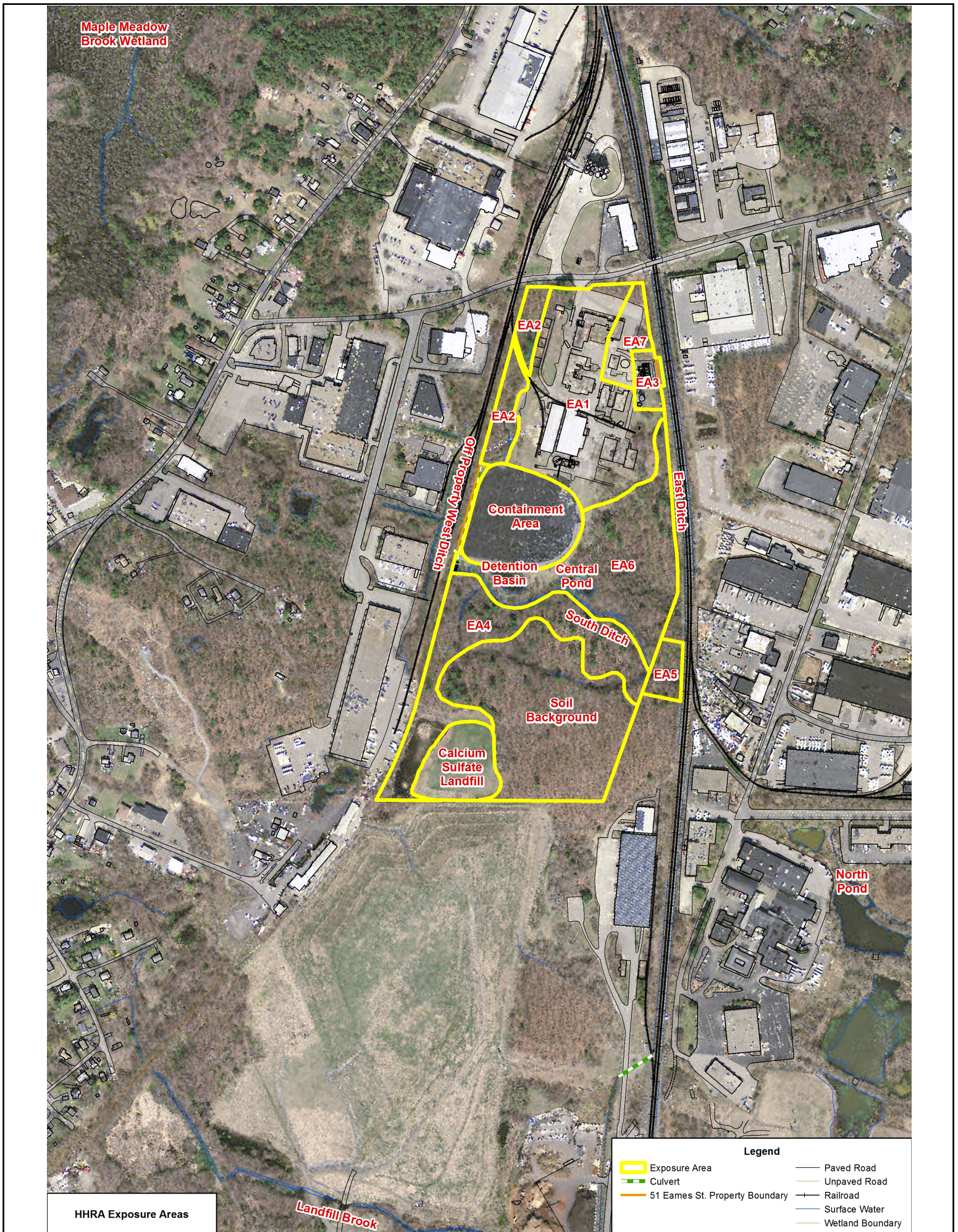


Figure 1. Division of Operable Unit (OU) 1 into Human Health Exposure Areas (HH-EAs) for the purposes of the risk assessments. OU2 features including HH-EA5, Off-Property West Ditch Stream, East Ditch Stream, and a portion of HH-EA3 are also depicted in this figure.

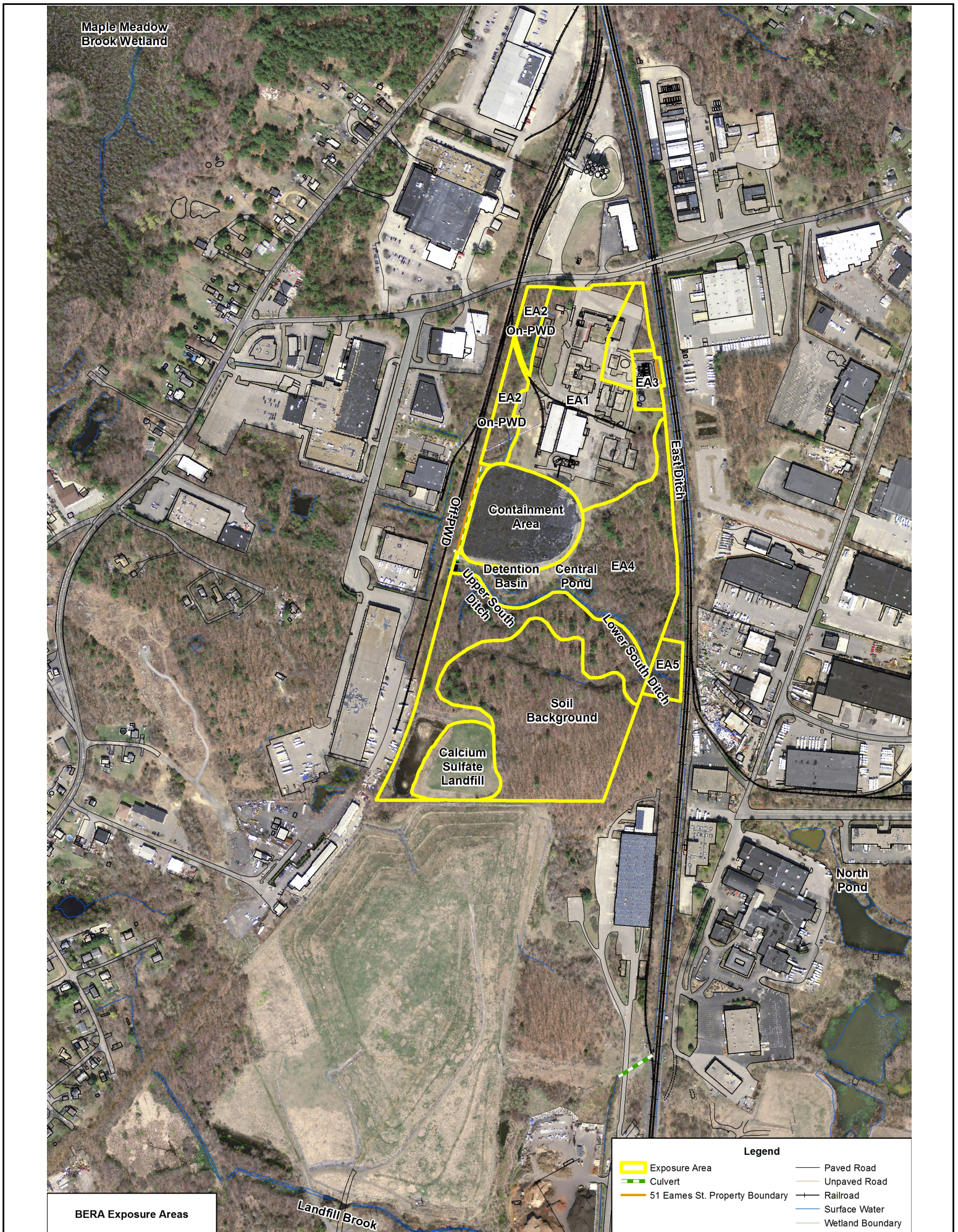


Figure 2. Division of Operable Unit (OU) 1 into Ecological Exposure Areas (E-EAs) for the purposes of the risk assessments. OU2 features including E-EA5, Off-Property West Ditch (Off-PWD) Stream, East Ditch Stream, and a portion of E-EA3 are also depicted in this figure.

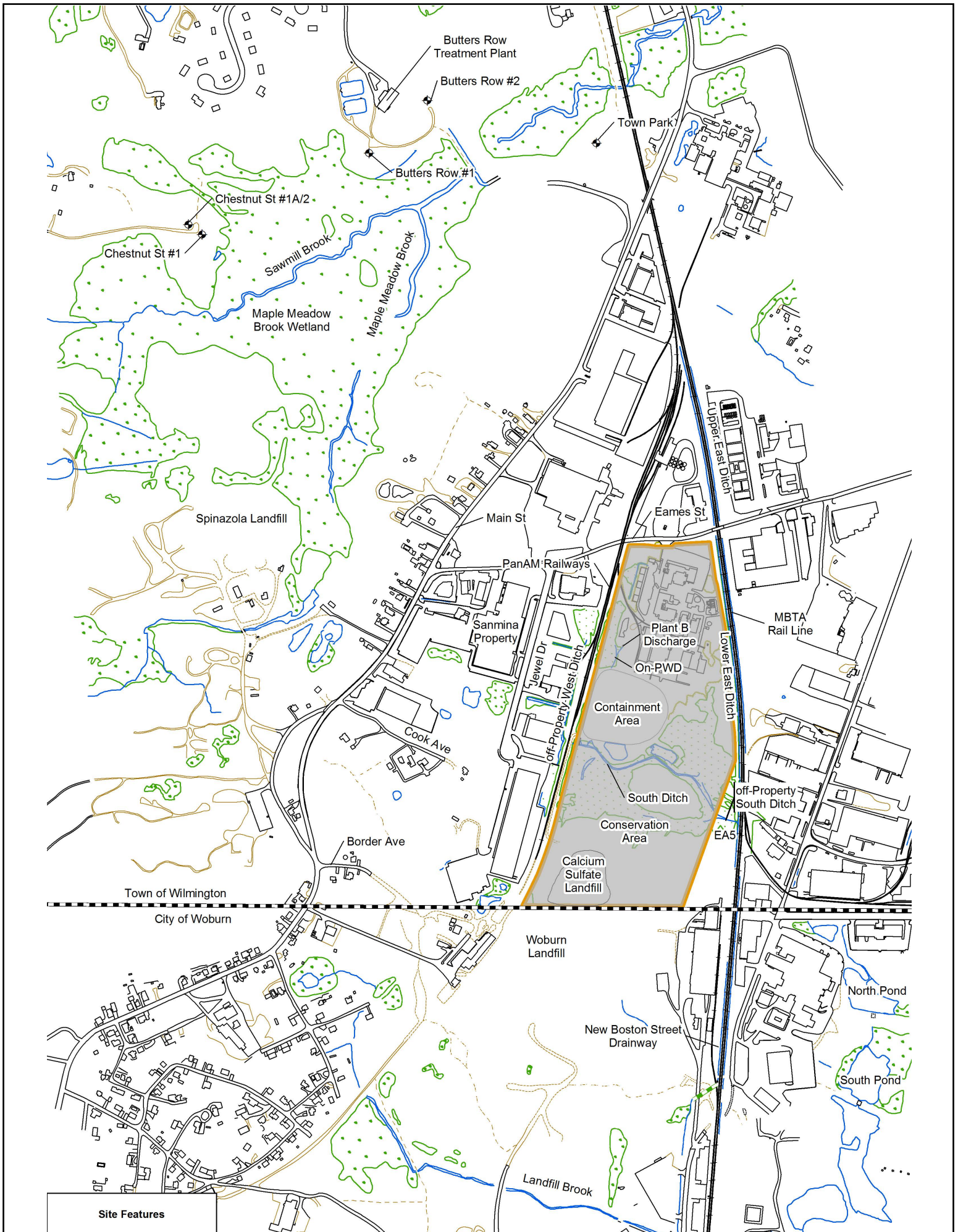


Figure 3. Operable Unit (OU) 2 surface water bodies. These include Off-Property West Ditch Stream, Sawmill Brook, and Maple Meadow Brook to the west of the Olin property; East Ditch Stream to the east of the Olin property; Landfill Brook to the south of the Olin property, and North Pond to the southeast of the Olin property.

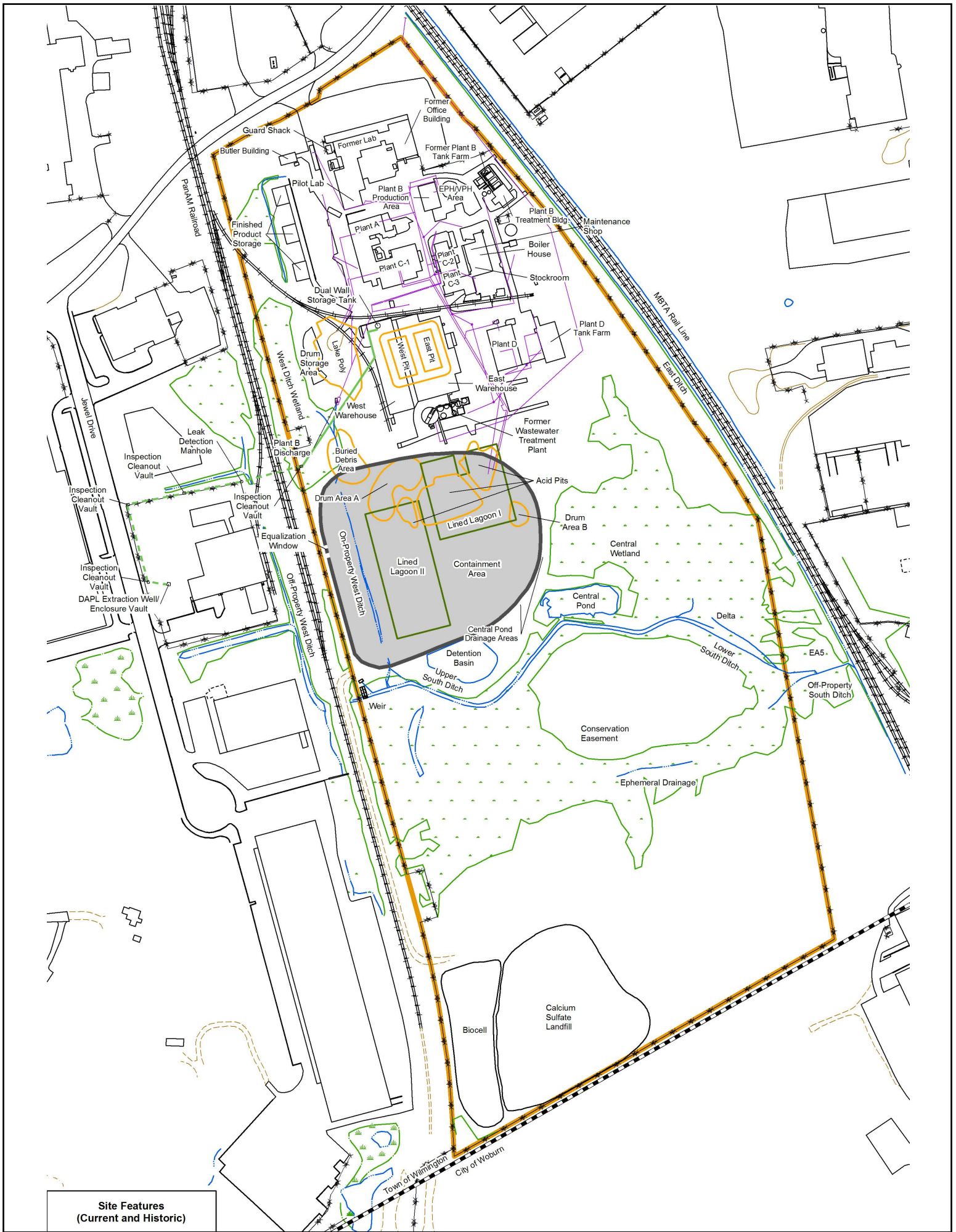


Figure 4. Olin property features (current and historic).